1003-3 Estimation of Mean Right Atrial Pressure in Critically Ill Patients Using Doppler Echocardiography

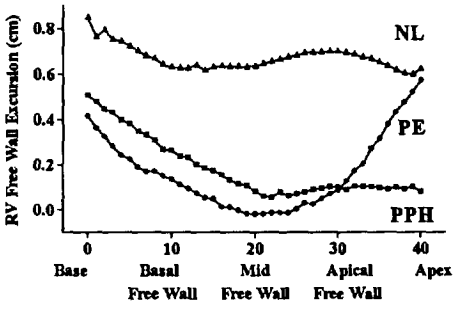
Sherif Nagueh, Helen A. Kopelen, William A. Zoghbi. *Baylor College of Medicine, Houston, TX*

Mean right atrial pressure (RAP) is a major determinant of right ventricular filling and is also needed for precise estimation of pulmonary artery pressures by Doppler echochardiography. Although ventricular and atrial Doppler filling parameters have been shown to relate to filling pressures, the majority of these studies have involved the left ventricle. To evaluate the accuracy of Doppler filling parameters in assessing mean right atrial pressure in critically ill patients, 35 patients (mean age 60 ± 15 yrs) in medical, cardiac and surgical intensive care units underwent simultaneous measurement of right atrial pressure and pulsed Doppler recording of tricuspid inflow and hepatic venous flow velocities. Thirty-four percent of patients were on mechanical ventilation. Mean right atrial pressure ranged between 2 and 28 mmHg (mean 9 ± 6). Left ventricular ejection fraction was 48 ± 15%. Of 6 tricuspid inflow variables, the strongest correlation with mean right atrial pressure was observed with the ratio of maximal early to late flow velocity (E/A) ($r = 0.6$). Among 8 variables analyzed from hepatic vein recordings, the highest correlation ($r = -0.86$) was seen with systolic filling fraction of hepatic vein flow velocity (SFF_{HV}; mean 0.53 ± 0.20) derived as the ratio of time velocity integral of systolic flow to that of systolic and diastolic forward flow. The best linear regression model correlating with mean right atrial pressure was: $RAP = 21.6 - 24\ SFF_{HV}$. This equation was tested prospectively in a group of 27 patients with a mean age of 64 ± 17 yrs and ejection fraction of 51 ± 14%. Mean right atrial pressure was 7 ± 5 (1–21 mmHg) and 41% of patients were on mechanical ventilation. Predicted mean right atrial pressure from SFF_{HV} using the regression equation correlated well with observed pressure in this prospective group ($r = 0.89$). For the total 62 patients, correlation between observed and predicted right atrial pressure was 0.87 with a mean difference between predicted and observed pressures of −0.8 ± 2.2 mmHg. For mean right atrial pressure of >10 mmHg, the sensitivity was 85% with specificity of 94%. Thus, mean right atrial pressure correlates significantly with right sided Doppler filling dynamics and is most reliably estimated in critically ill patients using Doppler echocardiography of hepatic venous flow.

1003-4 Echocardiographic Diagnosis of Acute Pulmonary Embolism: A Distinct Pattern of Abnormal Right Ventricular Wall Motion

Michael V. McConnell, Mamdouh E. Rayan, Scott D. Solomon, Patricia C. Come, Samuel Z. Goldhaber, Richard T. Lee. *Brigham and Women's Hospital, Boston, MA*

After observing an abnormal "hinge point" in the RV free wall of patients with acute PE, we tested the hypothesis that RV dysfunction (RVD) in acute PE has a distinct, regional pattern of abnormal wall motion. We quantitatively analyzed RV segmental wall motion in 3 patient groups: 1) 14 hemodynamically stable patients with acute PE and RVD; 2) 9 patients with primary pulmonary hypertension and RVD; and 3) 18 patients with normal studies (NL). Transthoracic echocardiograms were analyzed in random sequence by one investigator blinded to patient diagnosis. The RV free wall endocardium in the apical 4-chamber view was traced separately at end-systole and end-diastole for three cardiac cycles. Free wall excursion (FWE) was calculated for 40 segments with a modified centerline method. Patients with PE had a characteristic pattern of regional RVD. FWE was abnormal from the base through the apical free wall ($p < 0.02$ vs. NL for segments 0–36), but was near-normal at the apex ($p > 0.13$ vs. NL for segments 37–40). In contrast, patients with PPH had globally abnormal FWE ($p < 0.03$ vs. NL for segments 0–40) and differed from PE patients at the 5 most apical segments ($p < 0.03$ vs. PE for segments 36–40).



Conclusion: There is a distinct, regional pattern of RVD in acute PE, which differs from the global RVD observed in PPH. This pattern of RVD, which spares the RV apex, can suggest the diagnosis of acute PE.

1003-5 Feasibility of a Two Dimensional Echocardiographic Method for the Clinical Assessment of Right Ventricular Volume and Function

Howard D. Apfel, David E. Solowiejczyk, Margaret Challenger, Lawrence M. Boxt, Robyn J. Barst, Welton M. Gersony. *Columbia University, NY, NY*

Obtaining non-invasive measurements of right ventricular (RV) volume and function has been a long standing challenge. Radionuclide techniques (MUGA) for RV evaluation are limited by problems of border recognition and chamber overlap. Magnetic Resonance Imaging (MRI) measurements of ventricular volumes have been previously validated; however, this technique is limited by expense and time necessary for acquisition and analysis. A 2D echo technique has been previously described (Levine et al Circ 69: 497) that uses the simple product of length and area measurements of two orthogonal planes (apical 4 chamber and subxyphoid short). Apical (AP) and RV Outflow (OT) methods were used. Good correlation has been reported in vitro, however, no validation in a clinical setting has been reported to date. We obtained 2D echo measurements of RV volumes and election fraction (EF) by this method and compared our results to MRI data in patients over a wide range of volumes and function. 8 patients were studied, ages ranged from 5 to 42 years.

Results:

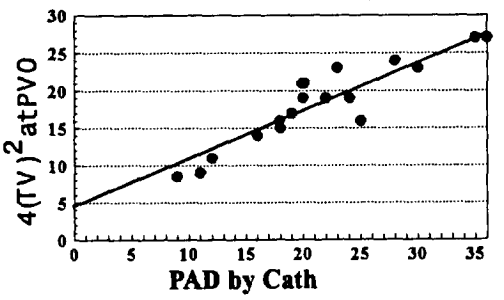
			Regression		Bias (mean percent differences)	Variability (intra-observer)
2D vs. MRI		MRI range	r	SEE		
EDV (AP)	7	53–302 ml	0.99	13 ml	−24%	12%
ESV (AP)	7	27–224 ml	0.99	9 ml	−19%	13%
EF (AP)	7	27–63%	0.99	4%	−27%	
EDV (OT)	8		0.98	13 ml	−24%	5%
ESV (OT)	8		0.99	7 ml	−30%	15%
EF (OT)	8		0.96	4%	−5%	

Conclusions: Preliminary data show an excellent correlation and small SEE of 2d echo volumes and EF compared to MRI. There is a significant 2D echo bias underestimating MRI. Assessment of EF by this 2D method may be clinically useful for serial follow up of RV function.

1003-6 Doppler Assessment of Pulmonary Artery Diastolic Pressure in Patients with Tricuspid Regurgitation

Bibiana Nagy, Prateek Dalal, Marvin Berger, Susan Hecht, Paul Schweitzer. *Beth Israel Medical Center, New York, NY*

A reliable Doppler echo method to assess pulmonary artery diastolic pressure (PAD) would be clinically useful. By applying the Bernoulli equation, $\Delta P = 4(V)^2$, an indirect estimate of RV pressure can be obtained from tricuspid regurgitant velocity (TV), if right atrial pressure is not significantly elevated. Since PAD and RV pressures equilibrate at the time of pulmonic valve opening (PVO), $4(TV)^2$ measured at PVO should approximate PAD. To test this hypothesis, we studied pts undergoing Swan Ganz monitoring who had tricuspid regurgitation detected by color flow Doppler. To avoid pts with marked elevation of right atrial pressure, we excluded pts with severe tricuspid regurgitation or evidence of right heart failure. The study group consisted of 20 pts. In each pt, TV was obtained by continuous wave Doppler. The time of PVO was determined by pulsed wave Doppler as the onset of systolic flow in the pulmonary artery, and the interval between the onset of the QRS and PVO was measured. This interval was then used to determine the point on the TV envelope that corresponded to the time of PVO. TV was measured at this point and $4(TV)^2$ was calculated using the Bernoulli equation. We compared $4(TV)^2$ at PVO obtained by Doppler with PAD measured invasively. PAD by cath ranged from 9 to 36 mmHg (mean 20). Measurement of $4(TV)^2$ at PVO ranged from 9 to 27 mmHg (mean 17) and showed an excellent correlation with cath PAD ($r = 0.91$, $y = 4.4 + 0.68x$, $SEE = 1.8$).



Conclusion: Doppler estimation of tricuspid regurgitant gradient at PVO is a reliable new method for estimation of PAD.